IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Walter SCHWARZENBACH et al.

Confirmation No. 3337

Application No.: 10/766,207

Group Art Unit: 2822

Filing Date: January 29, 2004

Examiner: Khan B. Duong

For: METHOD OF DETACHING A LAYER FROM A WAFER USING A LOCALIZED STARTING AREA

Attorney Docket No.: 4717-11600

APPEAL BRIEF FEE TRANSMITTAL

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

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Respectfully submitted,

8-8-08

Date

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BRIEF ON APPEAL

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Sir:

Applicants appeal to the Board of Patent Appeals and Interferences (the "Board") from the decision of the Examiner mailed December 13, 2007 rejecting claims 1, 4, and 8-22.

1. REAL PARTY IN INTEREST

The real party in interest is S.O.I. TEC SILICON ON INSULATOR TECHNOLOGIES S.A. ("Soitec"), a French company having a place of business at Parc Technologique des Fontaines, Chemin de Franques, F-38190 Bernin, France, the assignee of the entire right, title, and interest in the invention described and claimed in the above-identified patent application. The invention was assigned by Walter Schwarzenbach, Christophe Maleville, and Nadia Ben Mohamed to Soitec. The assignment was recorded on January 29, 2004 at Reel 015683, Frame 0912.

2. RELATED APPEALS AND INTERFERENCES

Applicants and their legal representatives are not aware of any appeal or interference that directly affects, will be directly affected by, or will have a bearing on the Board's decision in this appeal.

3. STATUS OF CLAIMS

Claims 1, 4, and 8-22 are pending and stand rejected in the present application. Claims 2, 3, and 5-7 are cancelled.

Claims 1-17 were submitted upon filing of this application on January 29, 2004.

In an Office Action dated September 20, 2005, claims 1-8 and 11-17 were rejected and claims 9 and 10 were indicated as being allowable but objected to as being dependent upon a rejected base claim. Claims 1-8, 11, 12, and 14-17 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent 6,597,039 ("Ohmi"). Claim 13 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of U.S. Publication 2003/0234075 ("Aspar").

In a response filed December 13, 2005, Applicants amended claims 1, 3-4, and 7-17; cancelled claims 2, 5, and 6; and added new claims 18 and 19.

In a Non-Final Office Action dated March 10, 2006, claims 1, 3, 4, and 7-19 were rejected. Claims 18 and 19 were rejected under 35 U.S.C. § 112 ¶ 2 as being indefinite. Claims 1, 3, 4, 7-9, 11, 12, and 14-19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of U.S. Patent 6,911,376 ("Yoo"). Claim 13 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of Yoo, and further in view of Aspar. The previously indicated allowability of claims 9 and 10 was withdrawn in view of the new rejection based on Yoo.

In a response filed May 23, 2006, Applicants amended claims 1, 9, 18, and 19.

In a Non-Final Office Action dated August 11, 2006, claims 1, 3, 4, and 7-19 were rejected.. Claim 19 was rejected under 35 U.S.C. § 102(e) as being anticipated by Ohmi. Claims 1, 3, 4, 7-9, 11, 12, and 14-19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of U.S. Patent 6,162,705 ("Henley"). Claim 13 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of Henley, and further in view of Aspar.

In a response filed November 6, 2006, Applicants amended claims 1, 8, 9, and 19; cancelled claim 7; and added new claims 20-22.

In a Final Office Action dated January, 29, 2007, claims 1, 3, 4, and 8-22 were rejected. Claims 20-22 were rejected under 35 U.S.C. § 112 ¶ 2 as being indefinite. Claims 1, 3, 4, 8-12, and 14-22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of Henley. Claim 13 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of Henley, and further in view of Aspar.

In a response filed March 27, 2007, Applicants amended claims 1, 9, and 19-22.

An Advisory Action dated May 14, 2007 indicated that the Applicants' after-final amendment would not be entered.

In a response accompanied by a Request for Continued Examination and filed on May 21, 2007, Applicants amended claims 1, 9, and 19-22 and cancelled claim 3.

In a Non-Final Office Action dated June 29, 2007, 1, 4, and 8-22 were rejected. Claims 1, 4, 8-12, and 14-22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of Henley. Claim 13 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of Henley, and further in view of Aspar.

In a response filed September 27, 2007, claim 12 was amended.

In a Final Office Action dated December 13, 2007, 1, 4, and 8-22 were rejected. Claims 1, 4, 8-12, and 14-22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of Henley. Claim 13 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of Henley, and further in view of Aspar.

In a response filed May 5, 2008, Applicants amended claims 1, 9, 14, and 19 and cancelled claim 12.

An Advisory Action dated June 20, 2008 indicated that the Applicants' after-final amendment would not be entered.

Thus, the claims on appeal are the claims 1, 4, and 8-22 presented on September 27, 2007 in the response to the Non-Final Office Action dated June 29, 2007. Claims 1, 4, and 8-22 are presented in Appendix A.

4. STATUS OF AMENDMENTS

The last amendment to claims 1, 9, 12, 14, and 19 was filed on May 5, 2008 after the Final Office Action dated December 13, 2007. The amendment was not entered as indicated by the Advisory Action dated June 20, 2008 and this appeal is directed to claims 1, 4, 8-12 and 14-22 as presented on May 5, 2008.

5. SUMMARY OF CLAIMED SUBJECT MATTER

Please note reference to the specification of the present application will be made with the regard to the Published Application 2005/0028727 for convenience.

The present invention relates to a method of detaching a layer from a wafer. In a preferred method, the weakened zone is created in the wafer, such that it defines the layer to be

detached and a remainder portion of the wafer. Preferably, the weakened zone is disposed between the layer to be detached and the remainder portion. The weakened zone is created to include a main region and also a localized super-weakened region that is more weakened than the main region. Detachment of the layer from the remainder portion is initiated at the super-weakened region, such that the detachment propagates therefrom through the main region to detach the layer from the remainder portion.

Claim 1 recites a method of detaching a layer from a wafer. The method comprises the steps of creating a weakened zone in a wafer to define the layer to be detached, and initiating detachment of the layer from the remainder of the wafer at a super-weakened region within the weakened zone (Specification ¶¶ 17-20). The weakened zone created in the wafer includes a main region and a localized super-weakened region that is weaker than the main region (Specification ¶ 35). Detachment is initiated at the super-weakened region by applying a controlled detachment force produced by applying heat substantially evenly to substantially the entire weakened zone (Specification ¶¶ 21-27). The heating is controlled to apply heat substantially evenly to substantially the entire weakened zone so that the detachment force is applied to both the super-weakened region and the main region, and so that the detachment of the layer from the remainder of the wafer initiates and propagates from the super-weakened region through the main region (Specification ¶ 56).

Claim 9 also recites a method of detaching a layer from a wafer. Claim 9 contains all of the recitations of claim 1 identically and further recites that the heating is provided by heating elements that are independently controlled so that the heat can be evenly applied to the weakened zone (Specification ¶ 54).

Claim 19 also recites a method of detaching a layer from a wafer. Claim 19 contains all of the recitations of claim 1 identically and further recites that the detached layer obtained is substantially homogenous and has a low surface roughness and improved homogeneity compared to the surface roughness and homogeneity obtained from a conventional detachment annealing on a wafer having a weakened zone but not a super-weakened region (Specification ¶ 57).

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 4, and 8-22 of the present application stand rejected and are being submitted herewith for review on appeal..

Claims 1, 4, 8-12, and 14-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 6,597,039 ("Ohmi") in view of U.S. Patent 6,162,705 ("Henley").

Claim 13 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohmi in view of Henley, and further in view of U.S. Publication 2003/0234075 ("Aspar").

Applicants respectfully request the Board to reverse the above-mentioned obviousness rejections and allow claims 1, 4, 8-12, and 14-22.

7. ARGUMENT

Claims 1, 4, 8-12, and 14-22

The rejection of claims 1, 4, 8-12, and 14-22 under 35 U.S.C. § 103(a) based on Ohmi in view of Henley are in error because it fails to establish a prima facie case of obviousness. *See* MPEP § 2142. All of the independent claims 1, 9, and 19 recite, *inter alia*,

> initiating detachment of the layer from the remainder portion at the super-weakened region by applying a controlled detachment force obtained by heating at least the weakened zone wherein the heat is applied substantially evenly over substantially the entire weakened zone.

Because claims 4, 8, 10-12, 14-18, and 20-22 depend either directly or indirectly from one of claims 1, 9, and 19, they also incorporate this recitation. Applicants submit that the cited references neither teach nor suggest this feature of the invention. Thus, Applicants assert that the Examiner has not satisfied the burden to factually support the conclusion that claims 1, 4, 8-12, and 14-22 are obvious in view of the cited references.

In accordance with the claimed invention, a weakened zone is created within the thickness of a wafer to define a layer to be detached from the rest of the wafer. The weakened zone includes a main region and a localized super-weakened region that is weaker than the main region. This super-weakened region of the weakened zone has a weaker bond with the layer to be detached than does the main region of the weakened zone. Thus, when a controlled detachment force is applied to the entire weakened zone (i.e. main region and super-weakened region), detachment of the layer will initiate at the super-weakened region. The controlled detachment force is produced by applying heat homogenously to the entire weakened zone (i.e. main region and super-weakened region) until the layer is detached. The methods recited in the claims provide greater control of the detachment of the layer from the rest of the wafer and produce a detached layer having particularly low surface roughness. By contrast, in

conventional detachment methods where heat is not applied evenly and hot spots are allowed to form in the wafer, the detachment of the layer will initiate at and propagate from the various hot spots. When there are multiple hot spots, it is difficult to control the initiation and propagation of the detachment to produce a layer with a substantially planar surface.

The Examiner admits "Ohmi does not specifically disclose applying the heat substantially evenly over substantially the entire weakened zone to initiate and propagate detachment." *See* Office Action dated 12/13/07, p. 3. The Examiner asserts, however, that "Henley does use uniform heating of the entire substrate 2300 to initiate the cleaving action." *See id.* at 4. Applicants submit that Henley, in fact, teaches ***not*** using uniform heating of the entire substrate to initiate the cleaving action. Instead, Henley uses a directed energy source, such as localized heating or a localized mechanical force, to initiate a cleave front that controllably progresses across the wafer.

Henley discusses some of the same problems with detaching wafer layers that are addressed by the present application, but provides markedly different solutions. Henley points out that "[a] limitation with the use of random propagation among multiple cleave fronts is the possibility of having different cleave fronts join along slightly different planes or the possibility of forming cracks." *See* Henley 6:37-41. Henley warns that depending upon the magnitude of the difference between the planes of the cleave fronts, the film may not be of sufficient quality for use in manufacture of substrates. *See id.* at 6:49-52. Thus, Henley concludes that "it is generally undesirable to cleave a wafer using multiple fronts in a random manner." *See id.* at 6:53-55.

Henley further explains:

> An example of a technique which may form multiple cleave fronts in a random manner is described in U.S. Pat. No. 5,374,564, which is in the name of Michel Bruel ("Bruel"), and assigned to Commissariat A l'Energie Atomique in France. Bruel generally describes a technique for cleaving an implanted wafer by global thermal treatment (i.e., thermally treating the entire plane of the implant) using thermally activated diffusion. Global thermal treatment of the substrate generally causes an initiation of multiple cleave fronts which propagate independently. *In general, Bruel discloses a technique for an "uncontrollable" cleaving action by way of initiating and maintaining a cleaving action by a global thermal source, which may produce undesirable results.* These undesirable results include potential problems such as an imperfect

> joining of cleave fronts, an excessively rough surface finish on the surface of the cleaved material since the energy level for maintaining the cleave exceeds the amount required, and many others. *See id.* at 6: 55-7:5 (emphasis added).

Henley distinguishes over Bruel by pointing out that the "invention overcomes the formation of random cleave fronts by a controlled distribution or selective positioning of energy on the implanted substrate." *See id.* at 7:5-8. In every embodiment of Henley, a *directed* energy source applies energy to a *selected* region of the substrate material to initiate a cleave front that propagates until a layer is detached. *See id.* 9:18-22; *id.* at 7:51-64 ("the impulse is directed at an edge of the substrate . . . . a source applies multiple impulses successively to the substrate"); *id.* at 8:6-14 ("the pulse is a laser pulse where an impinging beam heats a selected region of the substrate through a pulse"); *id.* at 9:29-35 ("an energy source such as a laser directs a beam in the form of a pulse at an edge of the substrate to initiate the cleaving action"). Further, Henley explains that the "invention does not require increasing the entire substrate temperature to initiate and sustain the cleaving action as pre-existing techniques." *See id.* at 10:21-24. Henley does provides global heating, but only to increase the built-in energy or stress of the substrate material, and never to a level that is sufficient to initiate the cleaving action to detach a layer. *See id.* at 8:18-23; *id.* at 8-59-63 ("the global energy or built-in stress is increased <u>but does not initiate</u> the cleaving action"); *id.* at 9:5-8 ("The wafer is heated to increase damage to or stress to the selected implanted region without initiating the controlled cleaving action"); *id.* at 9:29-34, 9:47-55, 9:64-10:1 ("the energy level or state of the substrate is raised . . . but is lower than the energy state necessary to initiate the cleave front").

Henley expressly teaches away from the very feature that the Examiner is relying upon it to provide. The rejection of the claims rely on the assertion that "Henley does use uniform heating of the entire substrate 2300 to initiate the cleaving action", but the portions of Henley cited above shows that Henley teaches directly the opposite. *See* Office Action dated 12/13/07, p. 4. Notwithstanding Henley's explicit teachings, and even assuming, *arguendo*, that global heating is used to initiate and sustain the cleaving action, there is nothing in Henley that teaches or suggests that the heat is applied uniformly over the substrate material. *See, e.g., id.* at 7:39-41 (listing numerous non-uniform thermal sources, including flood, time-varying, spatially varying, and continuous applications). As explained in the present application, subjecting a wafer to an environment at a constant temperature is <u>not the same</u> as applying heat substantially uniformly

over a surface. To accomplish uniform surface heating, the amount of heat provided often needs to be varied at different locations with respect to the wafer. *See*, e.g., present claim 9 and paragraph [0049] of the Published Application ("By selectively controlling the supply to the heating elements, . . . a spatially homogeneous, evenly distributed amount of heat may be applied to the wafers . . . over substantially the entire weakened zone of each wafer."). There is no disclosure, teaching or suggestion to do this in Henley.

As a result, neither Ohmi nor Henley teach or suggest a method of detaching a wafer comprising, *inter alia*, creating a weakened zone and applying heat substantially evenly over substantially the entire weakened zone. As a result, the Office Action fails to establish a *prima facie* case of obviousness. *See* M.P.E.P. § 2143. For at least this reason, Applicants respectfully request that the rejection of claims 1, 4, 8-12, and 14-22 under 35 U.S.C. § 103(a) be withdrawn and the claims be allowed.

Claim 13

The Examiner's rejection of claim 13 under 35 U.S.C. § 103(a) based on Ohmi in view of Henley and further in view of Aspar is in error because it also fails to establish a prima facie case of obviousness. *See* MPEP § 2142. Claim 13 is dependent upon independent claim 1 and therefore incorporates all of the recitations of claim 1. For the same reasons stated above with respect to claim 1, Ohmi and Henley do not teach or suggest all of the features of claim 13. Further, Aspar does not remedy the deficiencies of Ohmi and Henley, because the references, whether alone or in combination, fail to teach or suggest what is recited in claim 13, including the recitations of claim 1, from which claim 13 ultimately depends.

Aspar discloses a method for cutting a block of material and the formation of a thin, transferable film. This may be accomplished by cutting out a block of material and separating the thin film through the application of "a thermal treatment and/or the application of mechanical forces acting between the superficial part and the embrittled zone." *See* Aspar ¶ 18. The Examiner, however, fails to show how heating sources in Aspar would apply heat substantially evenly over substantially the entire embrittled or weakened zone. Moreover, as with the heating sources in Henley, the thermal treatments used as a means of starting the separation in Aspar involve the use of heating sources that have previously been shown – and that would be recognized by one of ordinary skill in the art – to provide uneven heating of the substrate surface. *See* Aspar ¶ 55 ("separation initiator can be provoked by overheating the substrate locally (for

example with the aid of a laser or a local heat source)"). Thus, Aspar does not rectify the deficiencies found in Ohmi and Henley disclosed above. As a result, the Office Action fails to establish a *prima facie* case of obviousness. *See* M.P.E.P. § 2143. For at least this reason, Applicants respectfully request that the rejection of claim 13 under 35 U.S.C. § 103(a) be withdrawn and claim 13 be allowed.

8. CONCLUSION

In view of the preceding discussion, Applicants respectfully request that all of the Examiner's rejections of claims 1, 4, and 8-22 be reversed and the claims be allowed.

Respectfully submitted,

Date: 8-8-08

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APPENDIX A – CLAIMS APPENDIX

1. A method of detaching a layer from a wafer, which comprises:

creating a weakened zone in a wafer to define the layer to be detached and a remainder portion of the wafer, such that the weakened zone includes a main region and a localized super-weakened region that is more weakened than the main region; and

initiating detachment of the layer from the remainder portion at the super-weakened region by applying a controlled detachment force obtained by heating at least the weakened zone wherein the heat is applied substantially evenly over substantially the entire weakened zone, and wherein the heating is controlled for evening the heating applied to weakened zone such that the detachment initiates and propagates from the super-weakened region through the main region to detach the layer from the remainder portion; and wherein the detachment force is applied to both the super-weakened region and the main region.

2. (Cancelled)

3. (Cancelled)

4. The method of claim 1, wherein the detachment force is obtained by applying energy to weakened zone.

5. (Cancelled)

6. (Cancelled)

7. (Cancelled)

8. The method of claim 1, wherein the heating of the weakened zone comprises thermally annealing the wafer.

9. A method of detaching a layer from a wafer, which comprises:

creating a weakened zone in a wafer to define the layer to be detached and a remainder portion of the wafer, such that the weakened zone includes a main region and a localized super-weakened region that is more weakened than the main region; and

initiating detachment of the layer from the remainder portion at the super-weakened region to impart a controlled detachment force obtained by applying heat substantially evenly over substantially the entire weakened zone, and wherein the heating is controlled for evening the heating applied to the weakened zone such that the detachment initiates and propagates from the super-weakened region through the main region to detach the layer from the remainder portion,

wherein the heat is applied by heating elements that are independently controlled for evening the application of heat to the weakened zone; and wherein the detachment force is applied to both the super-weakened region and the main region.

10. The method of claim 9, which further comprises flowing a heat conducting gas over the wafer during thermal annealing.

11. The method of claim 1, wherein the weakened zone is created by implanting a dose of atomic species in the wafer.

12. The method of claim 11, wherein the super-weakened region is created by implanting an overdose of the atomic species compared to the dose of atomic species implanted in the main region.

13. The method of claim 12, wherein the atomic species is applied in substantially a single operation to both the super-weakened and main regions.

14. The method of claim 12, wherein an initial dose of atomic species is applied to the weakened zone, and the overdose is applied to the super-weakened region before or after the application of the initial dose.

15. The method of claim 1, wherein the weakened zone is created by producing a porous layer in the wafer.

16. The method of claim 1, wherein the weakened zone extends through a crystalline layer of the wafer.

17. The method of claim 1, wherein the wafer comprises a semiconductor material.

18. The method of claim 9, wherein the detachment is conducted under conditions sufficient to obtain a detached layer that is substantially homogenous and has a low surface roughness and improved homogeneity compared to the surface roughness and homogeneity obtained from a conventional detachment annealing on a wafer having a weakened zone but not a super-weakened region.

19. A method of detaching a layer from a wafer, which comprises:

creating an weakened zone in a wafer to define the layer to be detached and a remainder portion of the wafer, such that the weakened zone includes a main region and a localized super-weakened region that is more weakened than the main region; and

initiating detachment of the layer from the remainder portion at the super-weakened region by applying heat a controlled detachment force obtained by heating at least the weakened zone wherein the heat is applied substantially evenly over substantially the entire weakened zone, and wherein the heating is controlled for evening the heating applied to the weakened zone such that the detachment initiates and propagates from the super-weakened region through the main region to detach the layer from the remainder portion,

wherein the detachment force is applied to both the super-weakened region and the main region to obtain a detached layer that is substantially homogenous and has a low surface roughness and improved homogeneity compared to the surface roughness and homogeneity obtained from a conventional detachment annealing on a wafer having a weakened zone but not a super-weakened region.

20. The method of claim 1, wherein the localized super-weakened region covers an angular sector on the order of several degrees at the periphery of the weakened zone.

21. The method of claim 9, wherein the localized super-weakened region covers an angular sector on the order of several degrees at the periphery of the weakened zone.

22. The method of claim 19, wherein the localized super-weakened region covers an angular sector at the periphery of the weakened zone.

APPENDIX B – EVIDENCE APPENDIX

None

APPENDIX C – RELATED PROCEEDINGS APPENDIX

None